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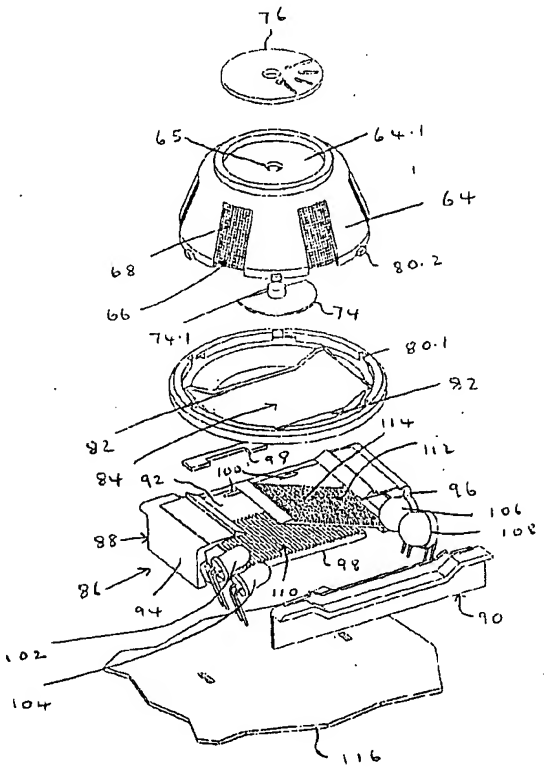
(54) Title: SMOKE DETECTORS

(57) Abstract

A smoke detector is disclosed which includes a smoke chamber having an inlet through which smoke can enter the chamber. In the chamber there are two light sources, preferably LEDs, which radiate light at frequencies which are as widely spaced as possible. Blue and infrared LEDs are preferred as these have wavelengths of about 430 nm and 980 nm respectively. The chamber also has therein one or more photosensitive devices onto which light scattered by smoke particles in the chamber falls. There is a barrier between the light sources and the photosensitive device to prevent light travelling in a straight line from the sources to the photosensitive device. Embodiments are disclosed which have more than two light sources, more than one photosensitive device and more than one smoke chamber.



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SMOKE DETECTORS

FIELD OF THE INVENTION

THIS INVENTION relates to smoke detectors.

BACKGROUND TO THE INVENTION

Smoke detectors operate by detecting the scattering of light which occurs when there is smoke in the casing of the detector. The detector includes a light source such as an LED or a laser which is activated at intervals to provide bursts of light. A photosensitive device detects any light which is reflected off smoke particles in the casing. In older types of detector, once the output of the photosensitive device reaches a predetermined level, an alarm condition is established at the control panel. In newer types of detectors the pattern of the signal being received from the detector is taken into consideration instead of, or as well as, a threshold value. Pattern recognition is used to determine the probability that the received signal indicates a fire thereby to reduce the possibility of false alarms being generated. False alarms are one of the major problems encountered in fire alarm systems.

Such smoke detectors, to the best of Applicant's knowledge, whilst able to detect low levels of smoke concentration, reveal nothing about the type of smoke.

BRIEF DESCRIPTION OF THE INVENTION

According to one aspect of the present invention there is provided a smoke detector which comprises a casing, two light sources for illuminating the interior of said casing, each light source producing light at a discrete wavelength, the discrete wavelengths being different to one another, and photosensitive means for detecting light from said sources after it has been scattered by particles in said casing.

The particles can be airborne smoke particles or particles which have adhered to inner surfaces of the casing.

Said photosensitive means can detect forward scattered light, or back scattered light, or both forward and back scattered light. Thus the smoke detector may include one or two photosensitive means.

It is preferred that both light sources and the photosensitive means are in the same chamber as one another. However, it is possible to provide one or more light sources and one or more photosensitive means in each of two or more chambers into which the interior of the casing is divided.

Said light sources can be LEDs of different colours. For discrimination purposes the wave lengths of the LEDs should differ from one another by as much as possible. Thus it is preferred to use an LED at the violet or blue end of the light

spectrum and an infra red LED which is at the opposite end of the light spectrum. For the purposes of the present specification infra red is to be deemed to be within the term "light" even though it is not visible to the human eye.

The light sources can be lasers emitting coherent light at different wavelengths.

Preferably one laser emits light at the blue / violet end of the spectrum and the other at the red / infrared end of the spectrum.

According to a further aspect of the present invention there is provided a method of detecting smoke particles which comprises illuminating the smoke particles using light at two discrete and different wavelengths and detecting the light which is scattered by the smoke particles.

The particles can be airborne smoke particles or particles, such as dust particles, which have settled on a surface.

In the preferred form smoke is illuminated alternately by light at a first wave length and by light at a second wave length. The first wave length can be at the infra red end of the light spectrum and the second wave length at the blue or violet end of the light spectrum.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which:-

Figures 1 to 6 each diagrammatically illustrates the mode of operation of a smoke detector in accordance with the present invention;

Figure 7 is an "exploded" view of a detector which operates in accordance with the mode of operation illustrated in Figure 4;

Figure 8 is a vertical, pictorial section through the detector of Figure 7; and

Figure 9 is a vertical section through the assembled detector.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring firstly to Figure 1, reference numerals 10 and 12 indicate two light sources which are mounted in the smoke detecting chamber of the smoke detector. The chamber has a barrier 14 for shielding a photosensitive device 16 from the light sources. The barrier 14 prevents light from the sources 10 and 12 travelling in a straight line to the device 16. The device 16 can include a lens for concentrating reflected light onto the photosensitive surface.

The light sources 10 and 12 are preferably an LED emitting light at the blue / violet end of the light spectrum (about 430 nm) and an LED emitting light at the infrared end of the light spectrum (about 980 nm). This ensures that the

difference between the wavelengths is as great as possible as this enhances discrimination.

The shaded area in Figure 1 indicates a concentration of smoke in the detecting chamber. The chamber is bounded by the casing of the detector and the casing has a plurality of openings therein which permit smoke laden air to enter the chamber.

The detector of Figure 1 detects what is known as forward scatter. In other words it detects light which has been reflected off the smoke particles at an angle but has continued on, as shown by the arrows, in the same general direction rather than being reflected back. Some light is also transmitted through some particles due to their translucence. The angle is shown as being about a right angle but in practice it is far more obtuse. The size of smoke particles, and their shape, varies with the type of material that is burning. Because of the difference in light wave lengths, the interaction between the light from one source and the particles differs from the interaction between light from the other source and the particles.

The sources 10 and 12 are illuminated out of phase with one another. It is preferred that the light sources are illuminated alternately. The output of the photosensitive device 16 is fed to a control panel, and software in the control panel can be used to differentiate between the output which has resulted from the scattering of the blue light and the output which has resulted from the scattering of

infra red light. The software can be used to determine smoke particle size, smoke particle shape, air velocity, concentration, colour and light absorption characteristics at the specific wave lengths. It can also be used to distinguish between smoke and dust particles. These abilities give information about the type of material that may be burning.

Some forms of smoke detectors incorporate processing software. In these forms the signal fed to the control panel has already been pre-processed and less processing power is required at the panel.

In Figure 2 there is a further photosensitive device 18 which detects back scatter. The term back scatter refers to light which has been reflected back towards the light sources. The device 18 is located as close to the sources 10 and 12 as the physical sizes of the sources and device 18 will allow.

The detector of Figure 3 has two infra red light sources 20 and 22 and two blue / violet light sources 24 and 26. It also has a single photosensitive device 28. The device 28 detects forward scatter from the sources 20 and 24 and back scatter from the sources 22 and 26.

Only two light sources 30 and 32 are shown in Figure 4 but there are two photosensitive devices 34 and 36. The photosensitive device 34 detects light at long wavelengths, that is, at the red end of the spectrum and the device 36 detects

light at short wavelengths, that is, at the blue / violet end of the spectrum. Both can include lenses for concentrating reflected light onto the photosensitive surface, and the device 36 can include a blue pass filter which blocks other wavelengths. The devices 34 and 36 detect forward scatter.

The detector of Figure 5 is similar to that of Figure 4 but includes two further devices 38 and 40 for detecting back scattered light at short wavelengths and back scattered light at long wavelengths.

Figure 6 shows a detector which has two blue / violet light sources 42 and 44, two infra red light sources 46 and 48, a photosensitive device 50 for detecting light at short wavelengths and a photosensitive device 52 for detecting light at long wavelengths. The devices 50 and 52 detect back scatter from the light sources 44 and 48 and forward scatter from the sources 42 and 46. The filter device 50 can include a blue pass filter.

In the embodiments of Figures 1 to 3, the structures are such that both light sources and the photosensitive device or devices must be in the same chamber as one another. In the embodiments of Figures 4 to 6 there can be more than one smoke chamber. For example, in Figure 4 the blue light source and the associated photosensitive device could be in one chamber and the infrared light source and associated photosensitive device could be in a second chamber. In the form of Figure 5 each chamber would contain one light source and two photosensitive

devices. In the form of Figure 6 each chamber would contain two light sources of the same colour and one photosensitive device. If the smoke detector does have two chambers then bursts of light of two colours can occur simultaneously.

Reflection off dust particles that have been deposited on the inside of the casing can be used for the purpose of calibrating the detector. Information derived from the two light sources may also be usable for the purpose of compensating for contamination of any lenses that are used.

Referring now to Figures 7 to 9, the smoke detector illustrated is designated 60 and comprises a frusto conical cover 62 the wall 64 of which has therein openings 66 which are covered by mesh 68 to prevent the ingress of insects and unwanted dust particles while permitting smoke to enter. Internal walls 70, which are ribbed to inhibit light reflection, lie internally of the wall 64. Between the walls 70 are slit-like smoke entrances 72 to the smoke chamber which is within the cover 62. The openings 66 are staggered circumferentially with respect to the entrances 72 to prevent ambient light entering the detector. The smaller end of the cover 62 is closed by an end wall 64.1 which has a central opening 65. An internal reflector 74 has a knob 74.1 which passes through the opening 65 and attaches the reflector 74 to an external adjuster 76.

The cover is secured to a ring 78 by means of an array of six bayonet connections the parts of which are generally designated 80.1, 80.2. The ring 78

includes partitions 82 which extend inwardly from opposite sides thereof and have between them a gap 84 for receiving a housing designated 86.

The housing 86 is in two parts 88 and 90, the part 88 comprising a vertical end wall 92, two side walls 94, 96 and a bottom wall 98. The other part 90 of the housing is in the form of a closure cap which can be ultrasonically welded to the part 88. Once the housing is in place clips 98 (only one of which is shown) are pushed through slots 100 the wall 92 and in the other part 90 to secure the ring 78 and housing 86 together.

Two light sources 102 and 104 and two photosensitive devices 106 and 108 are shown. The device 108 preferably has a blue pass filter over it so that all other light frequencies are blocked. The sources 102 and 104 are in a space 110 and the photosensitive devices in a space 112.

An inclined partition 114 separates the photosensitive devices 106, 108 from the light sources 102, 104 and prevents light travelling in a straight line from a source to a photosensitive device. The bottom wall 98 of the space 110 is ribbed, as is the partition 114, to inhibit light reflection as is well known in the art.

A printed circuit board is diagrammatically shown at 116, the light sources 102 and 104, the photosensitive devices 106 and 108 and the circuitry of the detector being mounted on this. The entire detector illustrated clips onto a base

(not shown) which is itself secured to a ceiling.

Smoke particles in the smoke chamber bounded by the walls 70 and reflect light onto the photosensitive devices 106, 108 and the output of these is used to determine whether an alarm condition has arisen.

Mechanical calibration is effected by rotating the reflector 74 thereby varying the light which reaches the photosensitive devices even in the absence of smoke particles.

It is possible to use lasers instead of LEDs. Lasers produce coherent light of narrow band width whereas the light from LEDs is not coherent and its band width is wider. Use of a red laser and a blue / violet laser is preferred thereby to obtain maximum separation of the frequencies.

CLAIMS:

1. A smoke detector which comprises a casing, two light sources for illuminating the interior of said casing, each light source producing light at a discrete wavelength, the discrete wavelengths being different to one another, and photosensitive means for detecting light from said sources after it has been scattered by particles in said casing.

2. A smoke detector as claimed in claim 1, wherein said photosensitive means detects forward scattered light.

3. A smoke detector as claimed in claim 1, wherein said photosensitive means detects back scattered light.

4. A smoke detector as claimed in claim 1 and including two photosensitive means one for detecting back scattered light and one for detecting forward scattered light.

5. A smoke detector as claimed in claims 1 to 4, wherein both light sources and the photosensitive means are in the same chamber as one another.

6. A smoke detector as claimed in claims 1, 2, 3 or 4 and including one or more light sources and one or more photosensitive means in each of two or more

chambers into which the interior of the casing is divided.

7. A smoke detector as claimed in claim 1, wherein said light sources are LEDs of different colours.

8. A smoke detector as claimed in claim 7, and including an LED which emits light at the blue / violet end of the light spectrum and an infra red LED which is at the other end of the light spectrum.

9. A smoke detector as claimed in claim 1, wherein said light sources are lasers emitting coherent light at different wavelengths.

10. A smoke detector as claimed in claim 9, wherein one laser emits light at the blue / violet end of the spectrum and the other at the red / infrared end of the spectrum.

11. A smoke detector as claimed in claims 1 to 4 and including means for firing the light sources alternately.

12. A method of detecting smoke particles which comprises illuminating the smoke particles using light at two discrete and different wavelengths and detecting the light which is scattered by the particles.

13. A method as claimed in claim 12, wherein the smoke is illuminated alternately by light at a first wave length and by light at a second wave length.

14. A method as claimed in claim 12, wherein said first wave length is at the infrared end of the light spectrum and the second wave length is at the violet or blue end of the light spectrum.

15. A method as claimed in any one of claims 12 to 14 and including the step of triggering the light sources alternately.

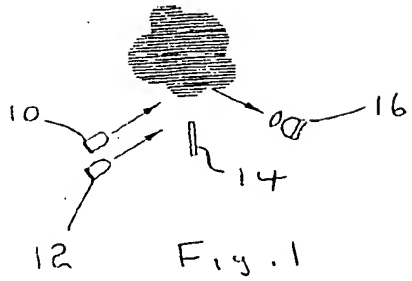

Fig. 1

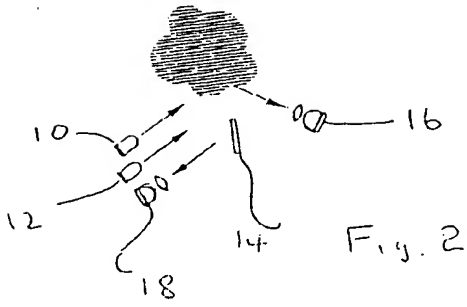

Fig. 2

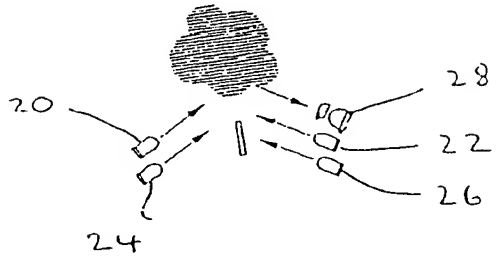

Fig. 3

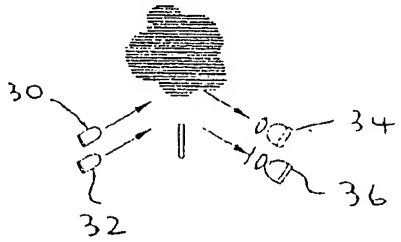

Fig. 4

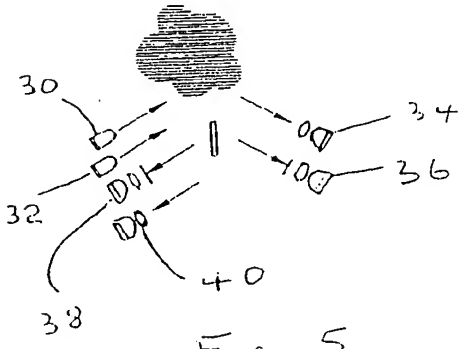

Fig. 5

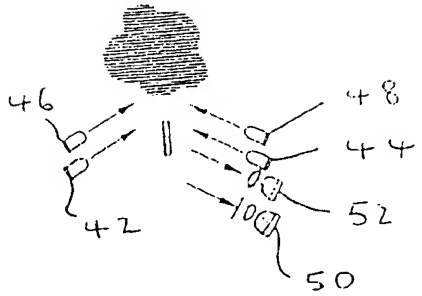

Fig. 6

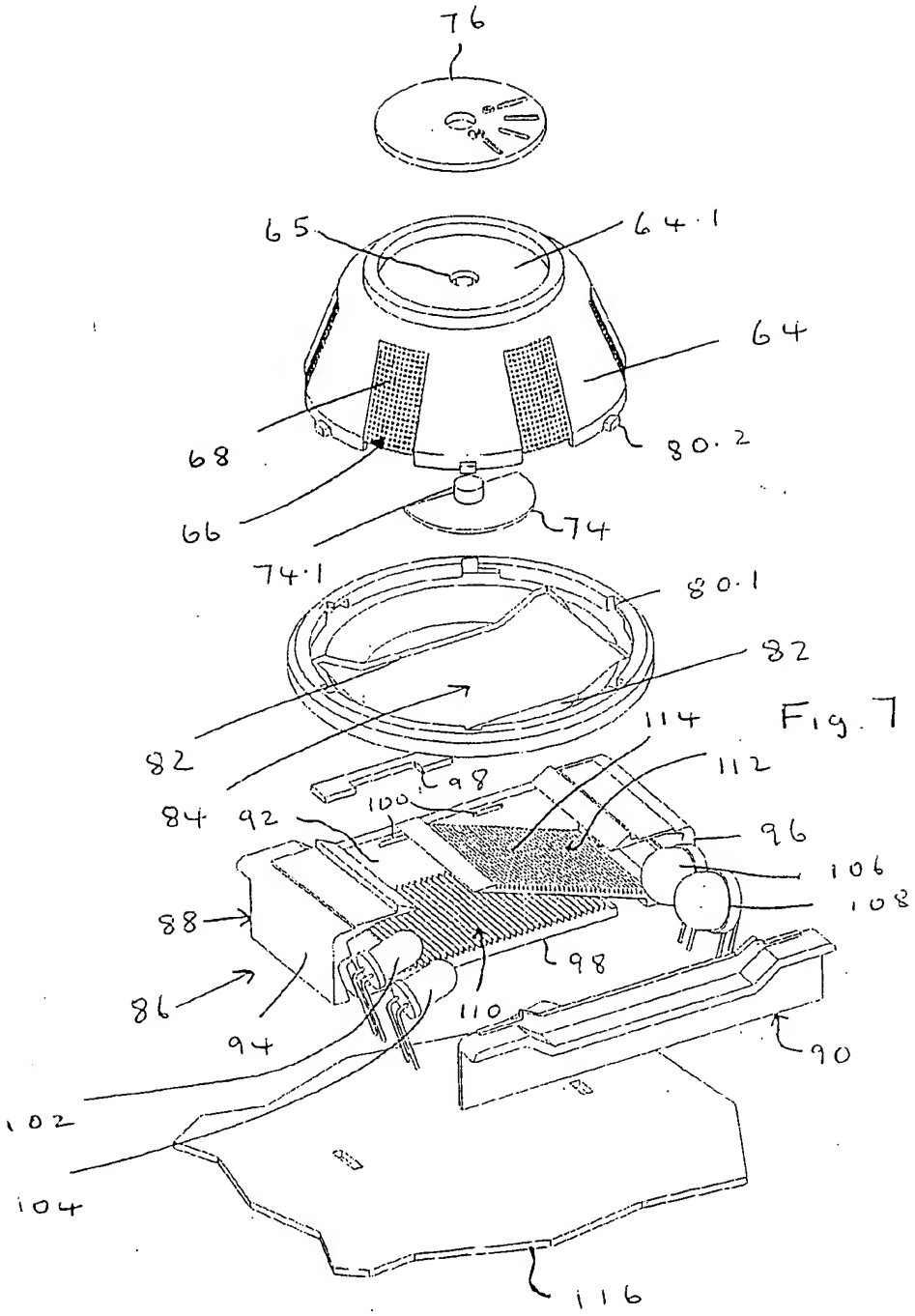
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Fig. 7

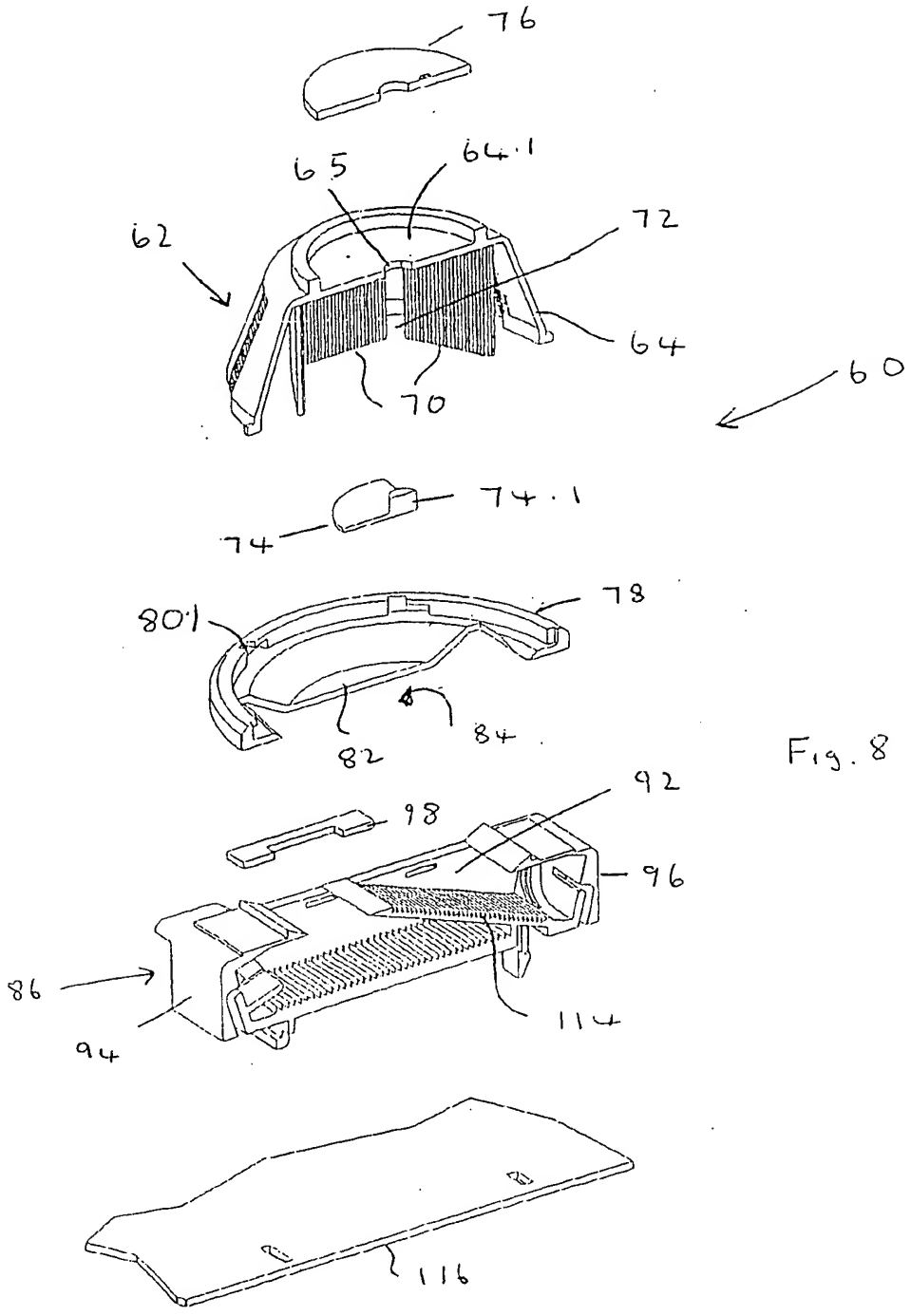

Fig. 8

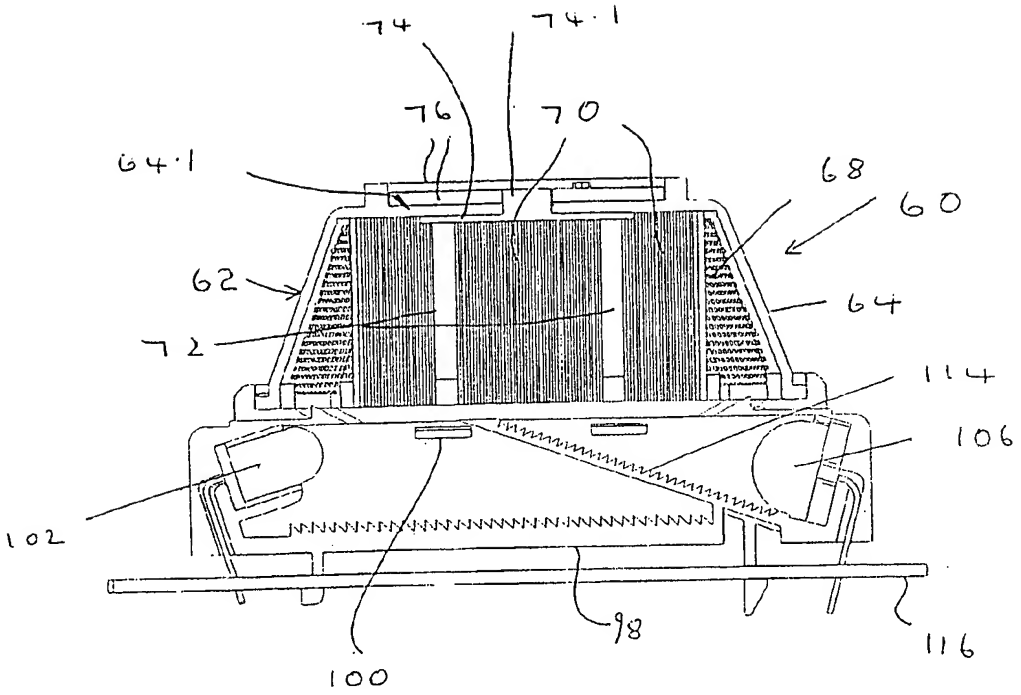

Fig. 9

INTERNATIONAL SEARCH REPORT

Int· ·ational Application No
PCT/ZA 99/00059

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G08B17/107 G01N21/53

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G08B G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	GB 2 319 604 A (KIDDE FIRE PROTECTION LTD) 27 May 1998 (1998-05-27) page 1, line 18 -page 3, line 7 page 8, line 14 -page 9, line 2 page 10, line 2 - line 7 figure 4 ---	1,2,5,7, 8,11-15 10
X	GB 2 273 769 A (ELLWOOD STEPHEN HENRY ;APPLEBY DAVID (GB)) 29 June 1994 (1994-06-29) page 1, line 24 - line 32 page 2, line 26 - line 41 page 5, line 41 -page 6, line 10 figures 1,4 --- -/--	1-7,12

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Date of the actual completion of the international search	Date of mailing of the international search report
28 October 1999	09/11/1999

Name and mailing address of the ISA	Authorized officer
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Inte' ational Application No
PC1/ZA 99/00059

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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X	ANONYMOUS: "Method for Localizing Light-Scattered Particles" IBM TECHNICAL DISCLOSURE BULLETIN, vol. 27, no. 5, page 3164 XP002120630 New York, US	1,2,5,9, 12
Y	the whole document	10
X	US 5 352 901 A (POORMAN RICHARD N) 4 October 1994 (1994-10-04) abstract column 2, line 58 - line 63	1-4,7,12

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte ational Application No
PC /ZA 99/00059

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2319604 A	27-05-1998	GB 2319605 A	27-05-1998
GB 2273769 A	29-06-1994	NONE	
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